Interbasin Transfer Projects: Impacts on Communities and Ecosystems

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Introduction

Total annual withdrawals of ground and surface water in New Mexico for all uses are just under 4,000 KAF/yr (Longworth et al., 2008). Although this value has not changed in many years, increasing population and economic activity has resulted in increased demands for this water. This increased demand extends throughout the state and is most clearly described in the sixteen regional water plans submitted to the Interstate Stream Commission between 1994 and 2008. In spite of the large differences in hydrologic conditions in this state, a common thread in all of these plans is that all water resources in each region are over appropriated and the region must obtain new sources of water both to support the existing uses and to allow growth of population and economic development.

The challenges of meeting future water demands are further complicated by the likely effects of climate change. Hurd and Coonrod (2008) explored the consequences of a variety of future climate scenarios and estimated that a reduction in annual runoff of up to 29 percent might occur by 2080. The problem of reduced runoff volume will be exacerbated by earlier snow melt and spring runoff, as well as and warmer summer temperatures resulting in increased evapotranspiration.

In an inland state with an arid climate such as New Mexico, there are only two sources of water that may be considered to be new: transfers of water from outside the watershed (interbasin transfers) and utilization of previously unused and unappropriated water. Desalination of brackish and saline groundwater is an example of the second source. While much attention has been devoted to wastewater reuse, in New Mexico most dischargers of wastewater receive return flow credits that are factored in the community's water rights. Thus, municipal wastewater is not usually really an unappropriated water source (Thomson and Shomaker, 2008).

Upon initial consideration, interbasin transfer of water has enormous appeal. Indeed, many of the regional water plans offer vague references to receiving water from adjacent basins. However, a more thorough examination reveals that there are often few details to support these transfers and in most cases, there is no real wet water available.

It is difficult to find information on interbasin water transfers because they are usually kept secret to minimize the uncertainty that comes with public disclosure. Although the State Engineer must approve each transfer, application to this agency usually comes near the end of the negotiating process. For example, the Augustin Plains Ranch proposal drew over 450 protestants when the application to divert water was filed in 2008 (Augustin Plains Ranch, LLC, 2011). A summary of several high profile interbasin water transfers that have been proposed or are in place in recent years is presented in Table 1.

Table 1. Examples of interbasin water transfers that have been proposed, are in progress, or have been completed in New Mexico in recent years.

Applicant or Title	Description	Amount of Water (AF/yr)	Status
Augustin Plains Ranch LLC	Transfer groundwater from Plains of San Augustin to Rio Grande	54,000	Application Pending
Berrendo LLC	Pipe water from Pecos River near Ft. Sumner to Santa Fe	6,600	Application denied by State Engineer
Eastern New Mexico Rural Water System	Divert water from Ute Reservoir to communities on the eastern plains	16,450	Authorized by Congress, awaiting funds
Navajo-Gallup Water Supply Project	Pipe San Juan River water to Gallup and Native American communities	37,764	Funded at $180M of $870M total
San Juan Chama Project	Divert water from the Colorado River basin to Rio Grande basin	96,200	Diversion began in 1972
Sierra Waterworks LLC	Desalinate and transfer groundwater from Estancia Basin to Santa Fe	7,200	Inactive

The objective of this paper is to consider whether new sources of water are in fact likely to be viable and to discuss some of the issues associated with their development. The discussion is presented by considering two case studies, the Eastern New Mexico Rural Water Authority project known more commonly as the Ute Pipeline project, and the Sierra Waterworks proposal to desalinate brackish water from the Estancia Basin and pipe it to Santa Fe.

Eastern New Mexico Rural Water System

The Eastern New Mexico Rural Water System (ENMRWS) or Ute Pipeline, was a project conceived in the 1960s to provide water to communities in Quay, Curry, and Roosevelt counties (USBOR, 2011). Ute Dam was constructed in 1962 on the Canadian River and enlarged in 1986 creating a reservoir with a maximum capacity of 272,000 AF. Though the Canadian River subsequently flows into Texas and then Oklahoma, the Ute Pipeline project is possible because the Canadian River Compact gives New Mexico free and unrestricted use of water in the river as long as storage below Conchas Dam is less than 200,000 AF. Due to the presence of other lakes in the basin, 193,240 AF of water can be stored in Ute Reservoir before water must be spilled and delivered to Texas.

The New Mexico Interstate Stream Commission determined that the sustainable yield from Ute Reservoir is 24,000 AF/yr (USBOR, 2011). In its current form, the ENMRWS will transfer 16,450 AF/yr to communities participating in the project and 7,150 will be available to communities that are not part of the Ute Pipeline project (Table 2). The Ute pipeline will consist of a large pump station to lift water to the top of the caprock, a water treatment plant, and 151 miles of pipeline (Figure 1). The total cost is projected to be nearly $500M of which 75 percent is to be paid from federal funds, 15 percent by the State of New Mexico, and 10 percent from local funds.

Table 2. Apportionment of water from the Canadian River at Ute Reservoir

Participating Communities	Amount (AF/yr)	Existing Use (AF/yr)
City of Clovis	**12,292**	**6,453**
Village of Elida	**50**	**49**
Village of Grady	**75**	**21**
Village of Melrose	**250**	**143**
City of Portales	**3,333**	**2,149**
Town of Texico	**250**	**162**
Cannon AFB		**1,189**
Curry County	**100**	**714**
Roosevelt County	**100**	**140**
Nonparticipating Communities		
Village of San Jon	**150**	**55**
City of Tucumari	**6,000**	**1,208**
Quay County	**1,000**	**457**

Note: Water usages are 2005 values from Longworth et al. (2008). County totals exclude values for communities listed in this table.

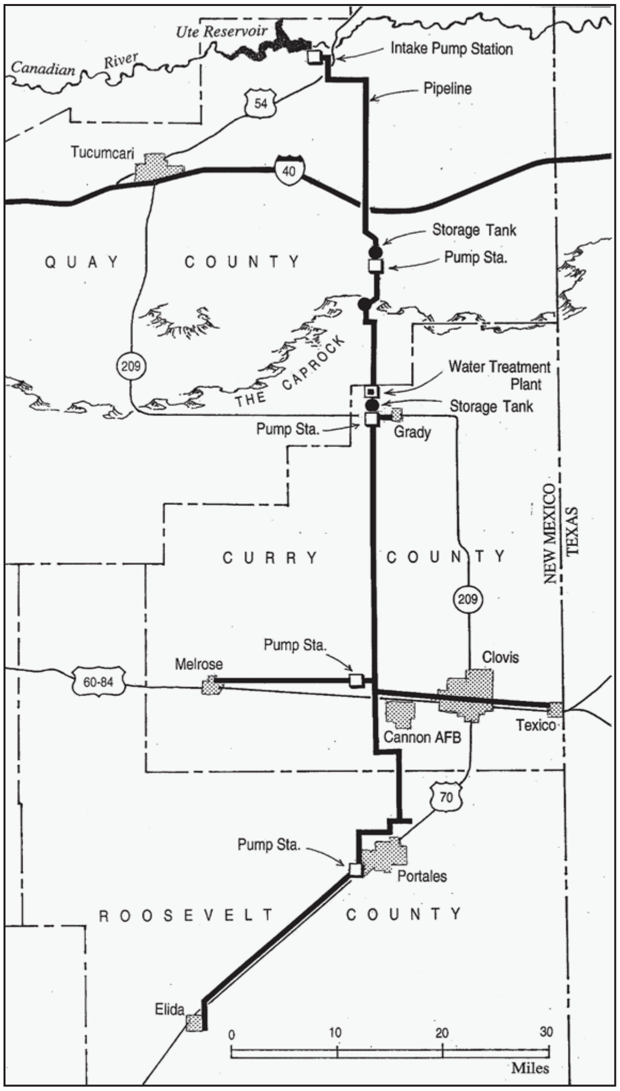

Figure 1. Eastern New Mexico Rural Water System (Utton Center, 2011)

The ENMRWS is justified because all of the communities in the region are entirely dependent on groundwater as their source of supply, primarily from the High Plains/Ogalalla Aquifer. Water levels in this aquifer are dropping rapidly due to extensive pumping, primarily to support irrigated agriculture (Table 3). This has placed enormous stress on public water utilities by forcing them to drill new and deeper wells and these wells are less productive because of the decreased thickness of the saturated zone. The experience in Clovis illustrates this; 62 wells were needed in 2010 to produce approximately the same flow as 29 wells did in 2000.

Table 3. Total annual water diversions in Curry, Quay and Roosevelt Counties (Longworth, 2008).

	Surface Water	Ground-water	Total
Commercial (self-supplied)	0	820	820
Domestic (self-supplied)	0	1,031	1,031
Industrial (self-supplied)	0	0	0
Irrigated Agriculture	37,632	324,833	362,465
Livestock (self-supplied)	332	18,905	19,237
Mining (self-supplied)	0	143	143
Power (self-supplied)	0	14	14
Public Water Supply	0	11,889	11,889
Reservoir Evaporation	26,181	0	26,181
Totals	64,145	357,635	421,780

There are three principal issues associated with this project: 1) sustainability, 2) environmental impacts, and 3) economic impacts.

Sustainability for the ENMRWS refers to the question of whether the source of supply can sustain the diversion. Average flow in the Canadian River at Logan, just downstream from Ute Dam since the reservoir was enlarged in 1985 is 25.5 KAF/yr, just slightly greater than the amount for the total project. However this average is skewed by very large flows exceeding 90 KAF in 1999, 1994, and 1987. If flows for these years are omitted, the average for the last twenty-five years is 14.8 KAF/yr. Of even more concern is the fact that the average flow in the river since 2001 is only 4.6 KAF/yr. Since the Canadian River Compact requires release of water when reservoir storage exceeds 200 KAF, it is not likely possible to store water from very wet years for multiple years.

Verhines and Gates (2008) report that dynamic simulation modeling of the reservoir shows a modest impact of the diversion on Ute Reservoir water levels. However, similar modeling done at UNM shows a ten-year sequence of dry years, as experienced since 2001, may cause lake volume to drop to less than 20 percent of its total capacity even if the total diversion is reduced to 15 KAF/yr.

The impacts of climate change will further diminish the amount of available water due to the effects of evaporation and diminished inflow. Pan evaporation at Logan is 84 in/yr. Modeling shows annual lake evaporation losses in excess of 20 KAF/yr when the reservoir is nearly full. This will increase with climate warming. Lake inflow from Ute Creek and the Canadian River will decrease due to increased evapotranspiration from the watershed and possibly decreased rainfall. These effects have not yet been modeled.

It is informative to consider the ENMRWS from the perspective of regional water use. While the projected safe yield of 24 KAF/yr will satisfy public water supply needs, it represents less than 6 percent of the total water diversions in the three counties (Table 3); virtually all of the rest of the demand is for agriculture and livestock watering. Thus, an obvious question is raised as to whether the water demand is justified in the face of inevitable declines in the agricultural sectors of the economy as groundwater resources are depleted. This is reflected in population projections for the region that show an approximate 10 percent increase over the next thirty years followed by a decline (Figure 2).

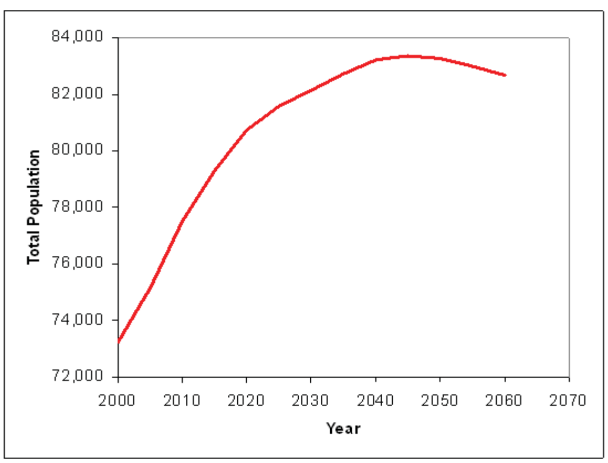

Figure 2. Population projections for Curry, Quay, and Roosevelt Counties (UNM Bureau of Business & Economic Research, 2008)

The economic consequences of the ENMRWS were discussed in the Environmental Assessment (USBOR, 2011). The principal impacts are the creation of jobs and construction expenses during construction of the project, and impacts on tourism and recreation in Ute Reservoir. Project water is to be used only for public supply and thus its economic impact is limited to that associated with replacement of dwindling groundwater supply with a presumably more sustainable surface water supply (USBOR, 2011).

Approximately 350 jobs would be created in the three counties during the five years of the construction phase of the project (USBOR, 2011). The completed project would produce few new permanent jobs, which would principally be associated with operation of the diversion, lift station, and water treatment plant. These jobs and the operating costs of the project would be paid for by increases in water rates for the utility customers, which are projected to range from \$164 to \$404 per year for each customer.

Perhaps the most uncertain economic impact of the ENMRWS is the potential negative impacts associated with tourism, recreation, and home ownership near Ute Reservoir. A sizeable economy has develop near the lake since it was formed that depends on maintaining a high water level in the lake. The spillway crest of Ute Dam is at elevation 3,787 ft. The USBOR predicts that lakefront and lakeview property premiums would drop 50 to 100 percent if water levels fall below 3,760 ft (USBOR, 20110), which corresponds to a total storage of 76 KAF. Dynamic simulation modeling of the reservoir done at UNM suggests the lake volume will drop to this level within ten years of operation if weather patterns of the past twenty years are repeated. The Environmental Assessment acknowledges that the impact of declining lake levels could be large but notes the difficulty in estimating the value. It is clear that more study needs to be done of this consequence.

Lessons Learned from the ENMRWS Project

The ENMRWS project has been evolving for over fifty years. The principal justification of this project is that communities in Curry, Quay, and Roosevelt counties are rapidly running out of water as water levels in the High Plains/Ogalalla Aquifer drop. The analysis described here identifies two questions regarding the project: 1) will the proposed project actually produce a sustainable supply of 24 KAF/yr, and 2) have the economic impacts been fully considered? Both are difficult topics to quantify and both have a high degree of uncertainty associated with them.

Brackish Water Development in the Estancia Basin

In 1962 then State Engineer Steve Reynolds estimated that 75 percent of the state's water resources were brackish (total dissolved solids or TDS concentration > 1,000 mg/L) or saline (TDS > 35,000 mg/L) (Reynolds, 1962). This estimate has not been quantified in part because this water was never considered to have any value. However, the combination of increased demand for water together with improvements and cost reductions in desalination technology has led to several proposed projects to use brackish water for public supply. Interest in brackish and saline groundwater resources was further increased by New Mexico water law, which did not give the State Engineer jurisdiction over deep aquifers (>2,500 ft) containing brackish water. This was changed by 2009 legislation but not before notices of intent to use 1.7 MAF/yr of deep brackish water were filed with the Office of the State Engineer (Utton Center, 2011).

The Estancia Basin is a 2,260 mi^2 closed basin located in central New Mexico east of the Sandia and Manzano mountains, which form the eastern boundary of the city of Albuquerque. The center of the basin is located in Torrance County but it extends into parts of Bernalillo, Santa Fe, San Miguel, and Lincoln Counties (Figure 3).

Most of the groundwater recharge in the basin is in the form of runoff from the Manzano Mountains to the west. There are six water bearing strata in the basin, however, nearly all pumping is from the shallow Valley Fill aquifer and the deep Madera Group (Table 4). Hawley (2004) studied this basin and published a series of geologic cross sections

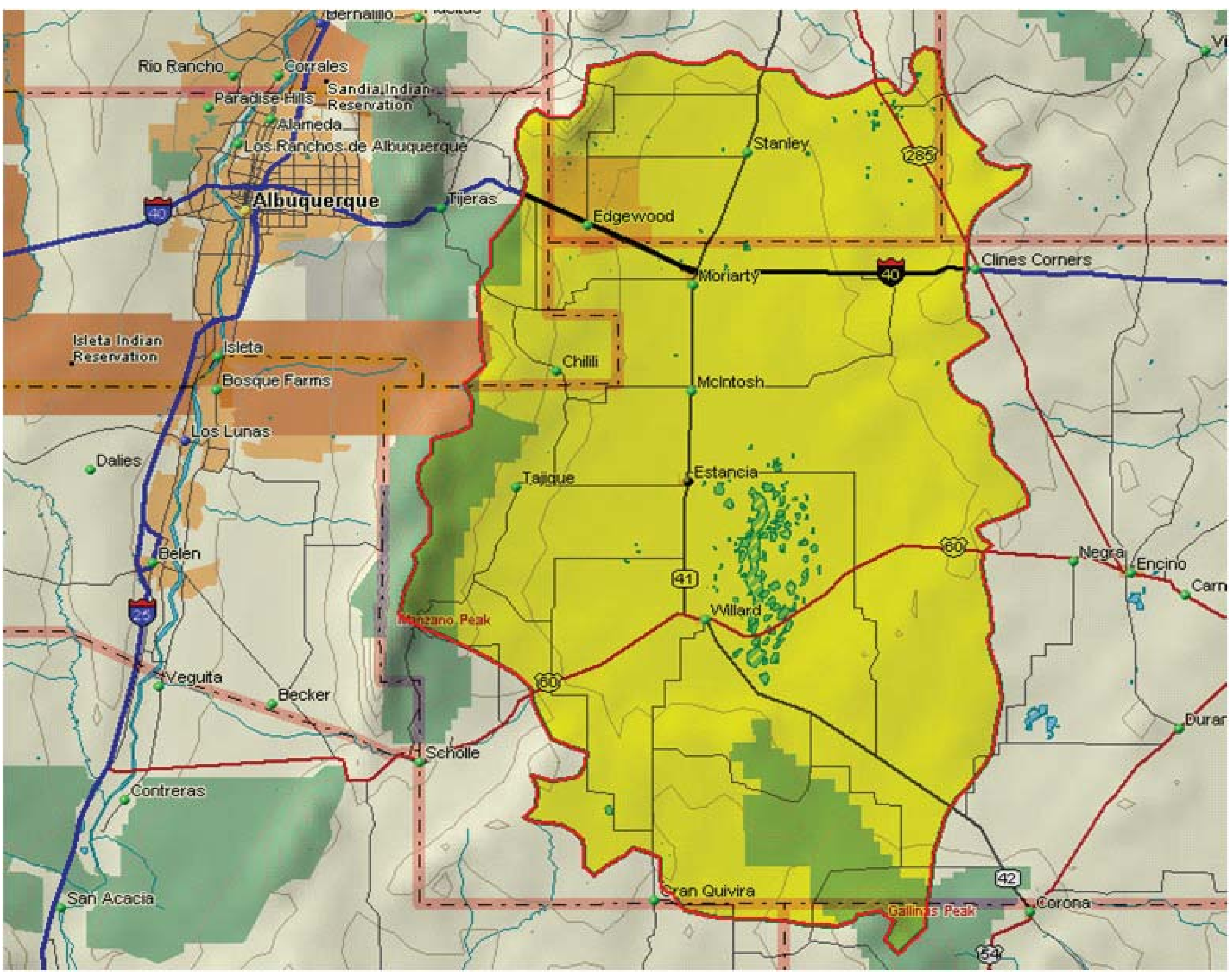

Figure 3. Location of the Estancia Basin (Thomas, 2004)

that identified a shear zone that is parallel to and a few miles east of State Highway 41. This shear acts to a large extent as a groundwater divide such that groundwater to the west has low TDS while that to the east is brackish with TDS values exceeding 3,000 mg/L in many wells.

Table 4. Principal aquifers in the Estancia Basin, the amount of water in storage, and their depletion rate (EBWPC, 2008)

Water Bearing Unit	Groundwater in Storage (MAF)	Depletion Rate (KAF/yr)
Valley Fill	6.58	52.1
San Andres Limestone	0.067	N/A
Glorieta Sandstone	5.85	N/A
Yeso Formation	23.8	N/A
Abo Formation	44.9	N/A
Madera Group	11.1	61.2

A proposal was made in 2005 to transfer 7,200 AF/yr of water from the east side of the basin to Santa Fe, New Mexico after desalinating it (Soussan, 2005). This constituted an interbasin transfer with a new twist that involved extraction and desalination of brackish water. It is informative to use this project to consider the impacts of this concept.

First, consider the impacts on groundwater resources. It is evident from Table 4 that groundwater resources in the Estancia Basin are all ready being depleted at greater than 110 KAF/yr. One of the consequences of this depletion is increasing salinity in public supply wells as shallow fresh water aquifers are depleted (White, 1994). The objective of the regional water plan was to reduce this overall depletion to 20 KAF/yr by 2040 (EBWPC, 2008). The proposed diversion is not consistent with this goal.

Thomson and others (2008) discussed development of brackish and saline water resources in New Mexico and surrounding regions and noted that, with few exceptions, these groundwater supplies are not sustainable. In most cases the water is very old and the high salinity is due to either concentration of dissolved minerals through evaporation or due to dissolution of soluble minerals present in the subsurface formation. In either case, the high salinity is evidence of very limited recharge, which would otherwise dilute the salt content. Thus, an obvious concern when considering brackish groundwater sources is its long term viability. Similar concerns have been raised regarding other proposals to develop brackish groundwater resources in New Mexico.

Introduction of desalination to the project adds a new layer of complexity. There are three concerns. First, desalination only recovers a fraction of the water that is treated. The Kay Bailey Hutchison Desalination Plant in El Paso, Texas treats groundwater with a TDS similar to that in the eastern Estancia Basin. It recovers 75 percent of the feed water. Thus, a plant to produced 7,200 AF/yr of water would have to pump 9,600 AF/yr of groundwater.

This leads to the second problem, concentrate disposal. A desalination plant produces a concentrate or brine that contains all of the salts from the desalination process. The Estancia Basin project would produce 2,400 AF/yr of salt water containing a TDS of approximately 12,000 mg/L, one-third the salinity of seawater. There are two options for concentrate disposal from an inland desalination plant: deep well injection and evaporation. Deep well injection as practiced in El Paso involves a 22-mile-long pipeline and three approximately 4,000 ft deep wells. Estancia is a bit unique because it is a closed basin with several salty playa lakes near its center. It might be possible to dispose of the desalination concentrate in these lakes, however, this would require a water balance study to determine its feasibility. Regardless, either disposal method would be costly and complicated.

The third challenge regarding the desalination process is the energy requirements. The energy required to produce 7,200 AF/yr of desalinated water was estimated at 11 Mwh/year for the desalination process alone. Concentrate disposal and pumping this water to Santa Fe would significantly add to this energy demand. Because New Mexico relies upon coal for electric power, the carbon footprint of the plant would be approximately 20,000 lbs of CO_2/d. It is clear that the power and environmental impacts of desalination projects are substantial.

Lessons Learned from the Estancia Basin Project

As with the ENMRWS, the fundamental issue of the Estancia Basin desalination and interbasin transfer project is whether the water supply is sustainable. Because the Estancia Basin project calls for development of a brackish groundwater source in a location with almost no recharge, this supply is not sustainable. The magnitude of the resource was not determined hence the lifetime of the project is not known. The fact that the groundwater resources is limited leads to another impact that isn't likely to be experienced with the ENMRWS, increased drawdown of neighboring wells and decreased water quality in them.

A second series of consequences of the Estancia Basin project are those related to the desalination process. One of the most significant is that desalination processes recover only a fraction of the water pumped, estimated at 75 percent. This means that a large volume of highly saline wastewater will be produced, which will require careful management to prevent environmental contamination. Finally, desalination processes require an enormous amount of energy that result in large emissions of CO_2. Although this factor is not considered in current interbasin transfer projects, it almost certainly has important environmental consequences and likely will be an important criterion in evaluating future projects.

Concluding Remarks

Interbasin transfer projects have considerable appeal as a means of increasing a community's or watershed's water supply. However, few resources are actually available. This paper examined some of the issues associated with interbasin transfers by considering two projects in New Mexico.

An analysis by the New Mexico Interstate Stream Commission shows that the Canadian River can provide 24,000 AF/yr sustainable supply to communities in eastern New Mexico. The Eastern New Mexico Rural Water System is a project to deliver 16,450 AF/yr of this total to Portales, Clovis and other communities in eastern New Mexico that has been approved by Congress but not fully funded. The analysis in this paper examines whether the watershed can actually provide this volume of water. A second concern regards the economic impact that the diversion would have on the economy of Ute Reservoir.

The second project considered in this paper is a project in which 7,200 AF/yr of water would to be pumped from the Estancia Basin to Santa Fe. This would entail pumping about 9,600 AF/yr of water from brackish aquifers in the eastern part of the basin and desalinating it. The issues raised in this paper deal with the long term sustainability of a brackish groundwater source, as well as the energy requirements and waste management concerns associated with the desalination process.

The issue of long term sustainability is a common thread in these and other interbasin transfer projects. Further concerns are the economic and environmental impacts. While environmental impacts appear to be limited for the ENMRWS, the economic consequences are substantial. For the proposed Estancia Basin water project, the principal environmental issues are centered around the impacts on the aquifer and other water users and those associated with concentrate disposal.

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